

VERSION WITH MARKINGS TO SHOW CHANGES MADE

58. (amended) [The method of claim 56, wherein said at least a portion of said total polishing period of time is substantially equal to or less than the last 10% of said total polishing period of time.] A Chemical-Mechanical Polishing (CMP) method for polishing Ta barrier layers in integrated circuit metallization structures including copper and silica, said method including flowing polishing slurry containing silica abrasive, DI water, and a copper passivation agent, onto a platen, inducing relative motion between said wafer and said platen and maintaining a force between said platen and said wafer, and removing said wafer from against said platen, said polishing occurring for a total polishing period of time, comprising,

incorporating into said polishing slurry for a final portion of said total polishing period of time less than or equal to 10% of said total polishing period of time, an organic additive selected from the group consisting of:

polyvinyl alcohol (PVA), PVA-poly(vinyl acetate) co-polymer, PVA-polyethylene co-polymer, sorbitol, glycerol, polyacrylamide (PAA), ethylene glycol, di(ethylene glycol), poly(ethylene glycol) (PEG), glycerol ethoxylate (GEO), dimethylsiloxane-ethylene oxide co-polymer (DMSiO-EO), polyethylene oxide surfactants, octylphenol polyethylene oxide, nonylphenol polyethylene oxide, polyoxyethylene lauryl ether, polyoxyethylene cetyl ether, perfluorinated analogs of polyethylene oxide surfactants, glycerol propoxylate (GPO), organic amines, N,N-diethylcyclohexylamine (DCA), and polyethyleneimine (PEI).

63. (amended) In a Chemical-Mechanical Polishing (CMP) method for polishing Ta barrier layers in integrated circuit metallization structures including copper and silica, said method including flowing polishing slurry containing silica abrasive, DI water, and a copper passivation agent onto a platen, inducing relative motion between said wafer and said platen while maintaining a force between said platen and said wafer, and removing said wafer from against said platen, said polishing occurring for a first polishing period of time, the improvement comprising:

decreasing said flow of said polishing slurry prior to said step of removing said wafer from against said platen; and

[flowing the polishing additive solution of claim 62]

following said step of decreasing said flow of said polishing slurry and prior to said step of removing said wafer from against said platen,
flowing a polishing additive solution onto said platen for a second period of time while inducing relative motion between said wafer and said platen and maintaining a force between said platen and said wafer;

said polishing additive solution comprising;

DI water;

a copper passivation agent selected from the group consisting of,

1,2,4-triazole, benzotriazole (BTA), imidazole, 5-methyl benzimidazole, polyaniline, indazole, and purine; and

an organic additive selected from the group consisting of,

polyvinyl alcohol (PVA), PVA-poly(vinyl acetate) co-polymer,

PVA-polyethylene co-polymer, sorbitol, glycerol,

polyacrylamide (PAA), ethylene glycol, di(ethylene glycol),

poly(ethylene glycol) (PEG), glycerol ethoxylate (GEO),

dimethylsiloxane-ethylene oxide co-polymer (DMSiO-EO),

polyethylene oxide surfactants, octylphenol polyethylene oxide, nonylphenol polyethylene oxide, polyoxyethylene lauryl ether, polyoxyethylene cetyl ether, perfluorinated analogs of polyethylene oxide surfactants, glycerol propoxylate (GPO), organic amines, N,N-diethylcyclohexylamine (DCA), and polyethyleneimine (PEI).

REMARKS

Claims 58-61 and 63-73 remain in the application after amendment.

35 USC 102 rejections

The Examiner has rejected claim 56 as being anticipated by Uzoh. Applicant has cancelled claim 56 and claim 57 dependent on claim 56 without prejudice to advance the prosecution of the application. Claim 58 has been amended to be of independent form.

35 USC 103 rejections

The Examiner has rejected claims 58-61 under 35 USC 103(a). Applicant respectfully traverses these rejections and requests reconsideration.

It appears that the Examiner may have misunderstood Applicant's motivation for the instant invention as claimed in claims 58 – 61. Applicant discovered that filter clogging was occurring during the CMP process, likely as a result of corrosion of the CMP equipment by the combination of CMP chemicals. The filter clogging was inducing unpredictable flow rate changes as well as other problems.

The Examiner has failed to provide any reasoning for the rejection of claims 58 – 60 and has restricted his remarks to the specific concentrations cited in claim 61 as being routine optimization. In doing so, the Examiner has failed to properly consider the inventive steps cited in claims 58 and 59, which involve using a two-step polishing process by having the organic additive included in the CMP slurry only at the very end of the polishing sequence. This two-step polishing sequence

has been developed as a method to minimize clogging of filters in the polisher (as stated in the specification, page 31, line 25), and to prevent copper staining and precipitates onto the wafer. There is no recognition by the Uzoh reference of any staining, precipitation, or clogging problems associated with the use of an organic additive during the entire polishing process, and Uzoh's process includes the Alkanol surfactant during the entire polishing period. Thus Uzoh teaches away from the two-step polishing process claimed in the present invention.

The Examiner has clearly not established a *prima facie* case for obviousness. Applicant respectfully requests that the rejections be withdrawn.

The Examiner has rejected claim 63 as being unpatentable over Uzoh. Applicant respectfully traverses this rejection. Examiner states that the steps of "decreasing said flow of said polishing (slurry) and flowing a polishing additive solution onto a platen for a second period of time..." would have been obvious "for the purpose of minimizing scratches on the wafer relative to the loading rate of the slurry." This premise may be in error. Examiner fails to take into account that the flowing of the organic polishing additive solution at the end of the polishing process is utilized to prevent copper staining and precipitates and equipment clogging. The Applicant's motivation is not associated with a decrease in scratching of the wafer. Further, whether or not scratching would be decreased by the process claimed would depend on the hardness of the precipitate. Applicant has not asserted that the invention improves the smoothness of the wafer surface.

The process claimed in claim 63 is a two step process whereby during the first period of time the abrasive-containing slurry without the organic additive is used to polish the wafer, and during the second period of time the slurry flow is decreased while the polishing additive solution is flowed to prevent or remove any

copper staining or precipitates, while not clogging the filters. There is no recognition by Uzoh of any problems associated with the use of an organic additive during the entire polishing process, and Uzoh's process includes the Alkanol surfactant during the entire polishing period. Thus Uzoh teaches away from the two-step polishing process claimed in the present invention.

Accordingly, Applicant respectfully requests that the rejection of claim 63 be withdrawn.

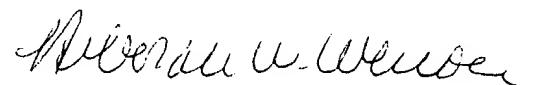
The Examiner has rejected claims 64-73 as being unpatentable over Uzoh. Applicant respectfully traverses these rejection. Claims 64-73 depend on claim 63 and claim specific process step orders, flow rates, and concentrations. Examiner asserts that "conducting routine experimentation for the purpose of reducing damage to the workpiece would optimize the selection of particular values for these variables". As described above, the Examiner fails to take into account that the flowing of the organic polishing additive solution at the end of the polishing process is utilized to prevent copper staining and precipitates and equipment clogging. The Applicant's motivation is not associated with a decrease in damage to the workpiece.

The process claimed in claims 64-73 is a two step process whereby during the first period of time the abrasive-containing slurry without the organic additive is used to polish the wafer, and during the second period of time the slurry flow is decreased while the polishing additive solution is flowed to prevent or remove any copper staining or precipitates, while not clogging the filters. There is no recognition by Uzoh of any problems associated with the use of an organic additive during the entire polishing process, and Uzoh's process includes the Alkanol surfactant during the entire polishing period. Thus Uzoh teaches away

from the two-step polishing process claimed in the present invention. Accordingly, Applicant respectfully requests that the rejection of claims 64-73 be withdrawn.

Applicant has made a diligent attempt to address all of the Examiner's points. It is believed that the application is now in condition for allowance. An early Notice is requested.

Respectfully submitted,



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